(i) CLAIMS

What is claimed is:

1

A microwave filter comprising:

a first piezoelectric acoustic, bulk wave, resonator having a piezoelectric layer made of an insulating material;

a second piezoelectric acoustic, bulk wave, resonator having a piezoelectric layer made of an insulating material, the second acoustic resonator being acoustically coupled to the first acoustic resonator; and

a plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the amount of the acoustic coupling between the first and second acoustic resonators.

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The microwave filter of claim 1 wherein the first acoustic resonator and the second acoustic resonator are acoustically either approximately critically coupled or over-coupled.

3

The microwave filter of claim 2 having a signal input port and a signal output port, the first acoustic resonator being electrically connected to the signal input port and the second acoustic resonator being electrically connected to the signal output port.

4

A microwave filter comprising:

a first piezoelectric acoustic, bulk wave, resonator;

a second piezoelectric acoustic, bulk wave, resonator, the second acoustic resonator being acoustically coupled to the first acoustic resonator; and

a plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the amount of the acoustic coupling between the first and second acoustic resonators and the first acoustic resonator and the second acoustic resonator being acoustically either approximately critically coupled or over-coupled.

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The microwave filter of claim 4 having a signal input port and a signal output port, the first acoustic resonator being electrically connected to the signal input port and the second acoustic resonator being electrically connected to the signal output port.

6

A microwave filter comprising:

a first piezoelectric acoustic, bulk wave, resonator;

a second piezoelectric acoustic, bulk wave, resonator acoustically coupled to the first acoustic resonator;

a third piezoelectric acoustic, bulk wave, resonator electrically connected to the second acoustic resonator;

a fourth piezoelectric acoustic, bulk wave, resonator acoustically coupled to the third acoustic resonator;

a first plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the amount of the acoustic coupling between the first and second acoustic resonators; and

a second plurality of intervening layers of material located between the third acoustic resonator and the fourth acoustic resonator and affecting the amount of the acoustic coupling between the third and fourth acoustic resonators.

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The microwave device of claim 6 in which the first, second, third and fourth acoustic resonators each has a piezoelectric layer made of an insulating material.

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The microwave device of claim 6 having a signal input port and a signal output port, the first acoustic resonator being connected to the signal input port and the fourth acoustic resonator being connected to the signal output port.

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The microwave device of claim 6 in which at least two of the acoustic resonators include piezoelectric layers of material and electrodes, each of said resonators having a resonant frequency, at least one electrode of the first one of said at least two acoustic resonators having a thickness that differs from the thickness of at least one of the electrodes in the second resonator of said at least two acoustic resonators thereby offsetting the resonant frequency of the first one of said at

least two acoustic resonators from the resonant frequency of the second one of said at least two acoustic resonators.

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A microwave filter having a signal input port and a signal output port and comprising:

a first acoustic, bulk wave, resonator that includes a piezoelectric layer of material, the first acoustic resonator being electrically connected to the signal input port;

a second acoustic, bulk wave, resonator acoustically coupled to the first resonator;

a third acoustic, bulk wave, resonator that includes a piezoelectric layer of material and that is acoustically coupled to the second resonator, the third acoustic resonator being electrically connected to the signal output port and the second acoustic resonator being located between the first and third acoustic resonators;

a first plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the acoustic coupling between the first and second acoustic resonators;

a second plurality of intervening layers of material located between the second and third acoustic resonators and affecting the acoustic coupling between the second and third acoustic resonators.

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The microwave filter of claim 10 in which the second acoustic resonator includes a piezoelectric layer of material and bounding electrodes and in which the second acoustic resonator is electrically connected to an external load.

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The microwave filter of claim 1 and further comprising:

a substrate;

an acoustic reflector; and

the first and second acoustic resonators and the plurality of intervening layers being supported upon the substrate by the acoustic reflector.

The microwave filter of claim 4 and further comprising:

a substrate;

an acoustic reflector; and

the first and second acoustic resonators and the plurality of intervening layers being supported upon the substrate by the acoustic reflector.

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The microwave filter of claim 6 and further comprising:

a substrate;

an acoustic reflector; and

the first, second, third and fourth acoustic resonators and the first and second plurality of intervening layers being supported upon the substrate by the acoustic reflector.

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The microwave filter of claim 10 and further comprising:

a substrate;

an acoustic reflector; and

the first, second and third acoustic resonators and the first and second plurality of intervening layers being supported upon the substrate by the acoustic reflector.

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An microwave acoustic device fabricated upon a wafer comprising:

a first microwave filter fabricated upon the wafer and having a pass-band frequency and the first microwave filter comprising:

a first piezoelectric acoustic, bulk wave, resonator having a conducting electrode;

a second piezoelectric acoustic, bulk wave, resonator, the second acoustic resonator being acoustically coupled to the first acoustic resonator; and

a plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the amount of the acoustic coupling between the first and second acoustic resonators;

and a second microwave filter fabricated upon the wafer and having a pass-band frequency and the second microwave filter comprising:

a first piezoelectric acoustic, bulk wave, resonator having a conducting electrode;

a second piezoelectric acoustic, bulk wave, resonator, the second acoustic resonator being acoustically coupled to the first acoustic resonator; and

a plurality of intervening layers of material located between the first acoustic resonator and the second acoustic resonator and affecting the amount of the acoustic coupling between the first and second acoustic resonators;

wherein the thickness of the conducting electrode in the first piezoelectric resonator of the first microwave filter differs from the thickness of the conducting electrode in the first piezoelectric resonator of the second microwave filter, whereby said difference in thicknesses causes the pass-band frequency of the first microwave filter to be shifted relative to the pass-band frequency of the second microwave filter.